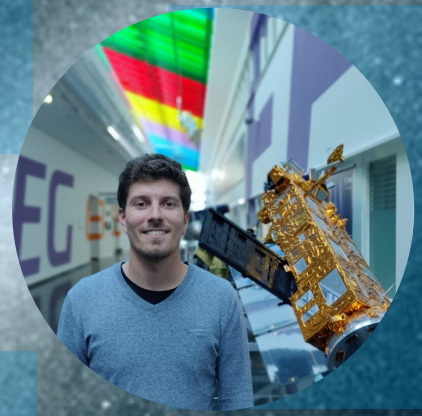
ESA Clean Space Industry Days 2022
Design for Demise: research and technologies development

SPEAKERS & MODERATORS

ANTONIO CAIAZZO

ESA-ESTEC Clean Space System Engineer



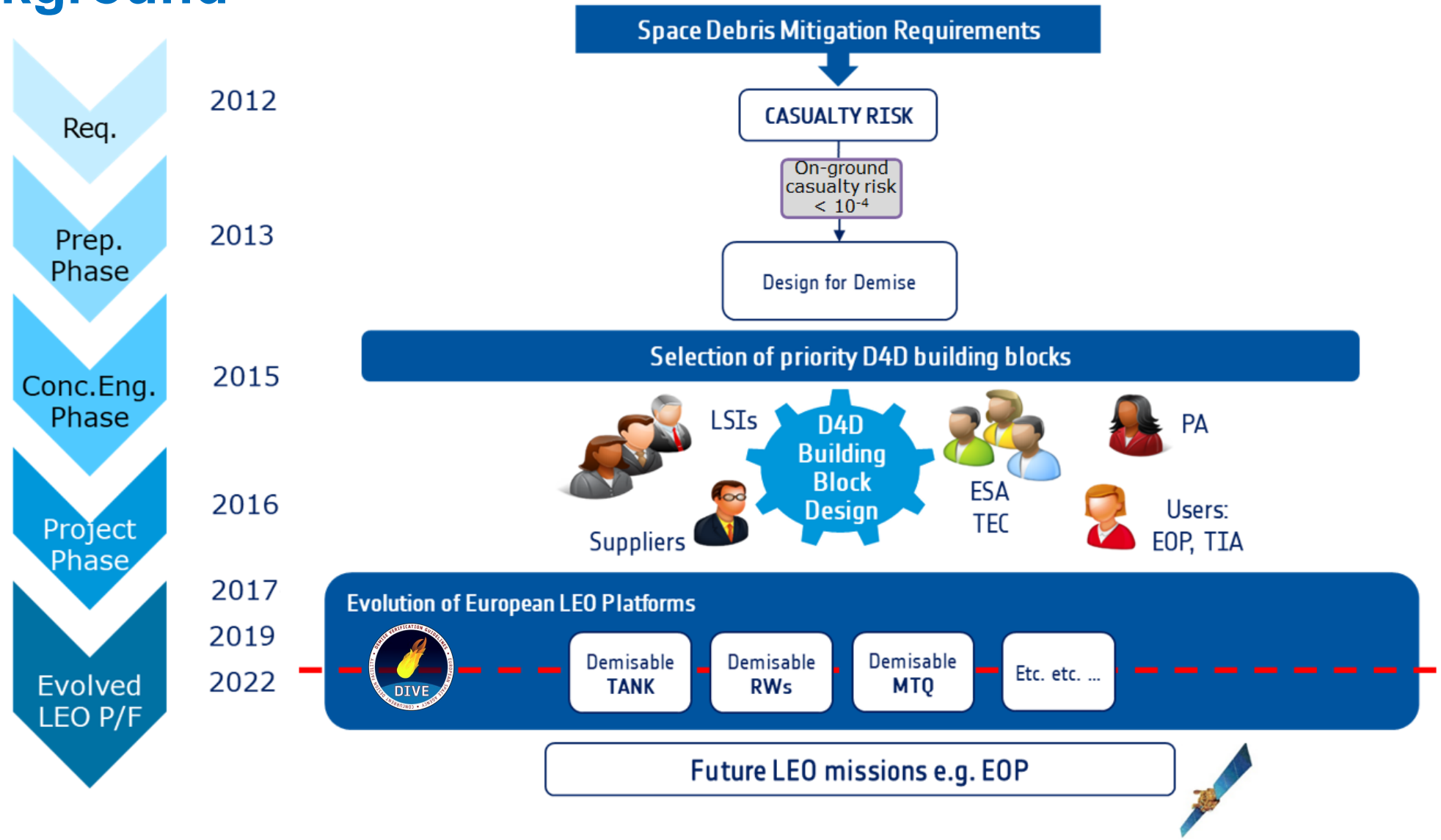
Benoit Bonvoisin

ESA-ESTEC Materials and Processes Engineer

Daniel Wishert

ESA-ESTEC System and CDF Engineer

Background



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Context

Critical elements

Object	Criticality	Reason
Battery	LOW	Cells have steel can / large number of cells
Electronics Card	MEDIUM	High GFRP failure temperature
Fill & Drain Valve	HIGH	Titanium part
Gyroscope	HIGH	Titanium housing
Magnetorquer	LOW	Magnetic core (higher melting point than steel)
Tank	HIGH	Titanium material
Reaction Wheel Shaft	MEDIUM	Steel material; multiple objects
Reaction Wheel Flywheel	HIGH	Steel material; multiple objects
Solar Array	LOW	Low ballistic coefficient
Structural Panels	LOW	Low ballistic coefficient (demise in component based model)
Mirrors (Zerodur)	MEDIUM	Zerodur material
Mirrors (SiC)	HIGH	Ceramic material
Thrusters	MEDIUM	Inconel material
Optical payload fixings	HIGH	Invar / titanium materials
Solar Array Drive Mechanism	HIGH	Steel central shaft
Star Tracker	HIGH	Internal titanium parts
Lenses	HIGH	Silica material

Demise techniques

Minimize Required Heat

- Minimize mass
- Replacing materials
  - C_p
  - T_m
  - ε
  - q_m

Maximize Available Heat

- Ballistic coefficient
- Increase local heat flux – Shapes of objects
- Add energy – Exothermic reactions

Optimize Heat Transfer

- Early break-up - Fragmentation
  - Dedicated mechanism
  - Demisable attachment points
- Orifices, lattice structure

Minimize Casualty Area

- Keeping re-entry fragments together - Containment

Vision

Zero Debris Platform – Fully Demisable

KNOWLEDGE

TRL

TRL7/8

TRL6

TRL4/5

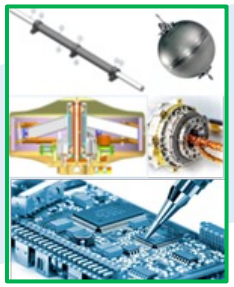
TRL2/3

TRL1

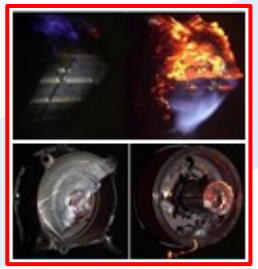
TIME

Demisable systems

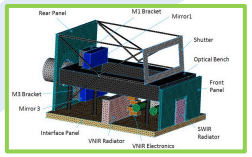
Demisable equipment, improved models and improved tests



Demisability tests, equipment development, complex models



Demisable equipment design, materials tests, re-entry simulations



Design for Demise for Payloads

System activities, simplified models, identification of critical equipment

Payload demise design and development

Opportunities for Flight Experiment under study

Simulation ⟷ Ground Testing ⟷ Flight Experimentation

2012-2014 | 2015-2017 | 2018-2020 | 2021-2023 | 2023-2025

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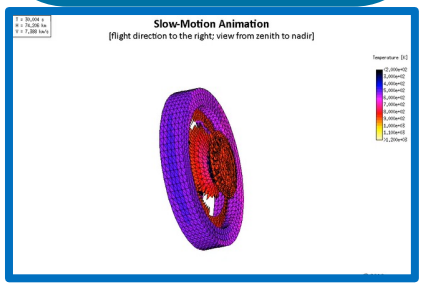
Pillars

- Complex shapes
- Material characteristics
- Uncertainties quantification



Simulation

Validation

Prediction

Flight Experimentation

- Observation measurements
- Experimental setup

[redacted]

Data requirements

Verification; Phenomenology

Verification

Qualification; Instrumentation Development

Ground Testing

[redacted]

- Test conditions
- Test measurements and test set-up
- Mimic the re-entry dynamic

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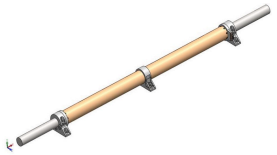
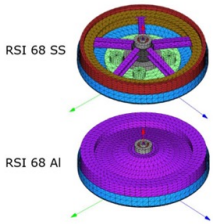
Technologies

Demisable technologies development

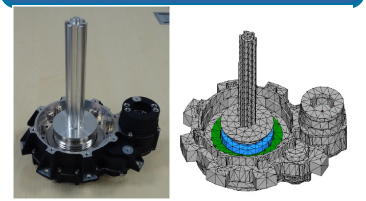
Demisable MTQ



Demisable Reaction Wheels



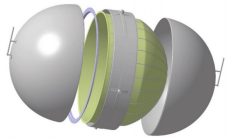
Demisable SADM



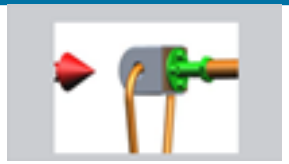
Demisable Joints

Demisable EP tank

Demisable propellant tank



Containment solutions



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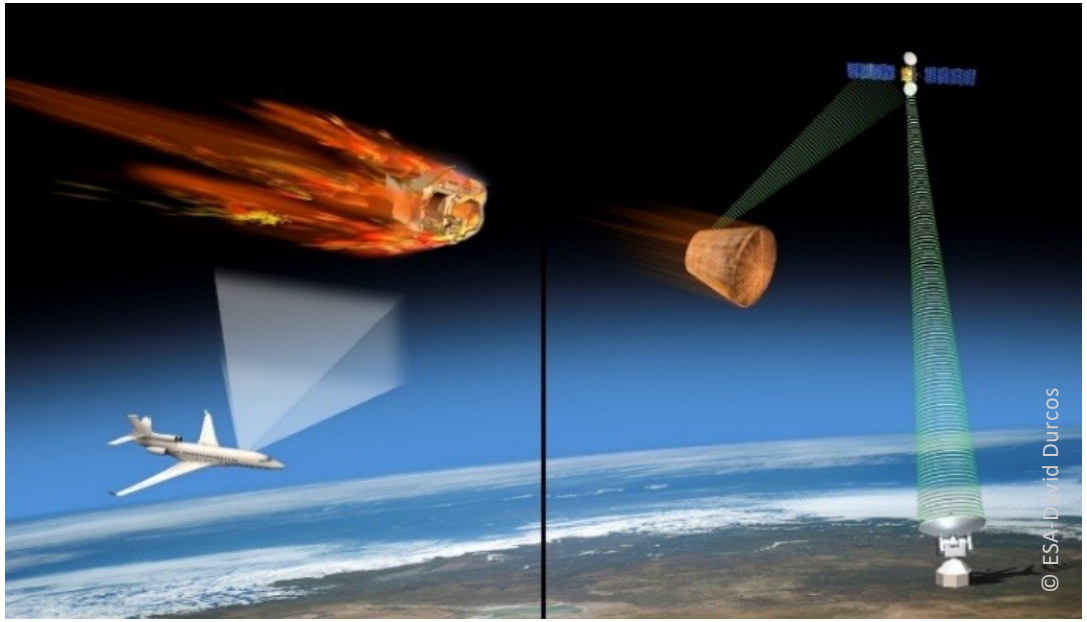
Opportunity

Flight Experiment - DRACO (Destructive Re-entry Assessment Container Object)

Status:

- Phase A mission study running Instrument design study set-up
- The world's first demonstration of a controlled break-up process of a spacecraft during re-entry to extrapolate ground-test to flight.
- Unique opportunity to establish an understanding of the physics of destructive aerothermal break-ups
- Opportunity to test early fragmentation design for demise (D4D) techniques and solutions!



Clean Space Industrial Days 2022
Thursday 13 Oct at 16:45 CET

Questions?